Unit 6 Lecture 14

Mycology

Introduction to Mycology

The characteristics of the kingdom Myceteae are first and foremost that the cells are Eukaryotes, which means the cells have a defined nucleus and cellular organelles (refer to chapter five in your text). The cells can be unicellular to multicellular, and have cell walls that possess chitin and/or cellulose. Fungi are obligate heterotrophs; they live off other organic matter. The kingdom is diverse. Structurally, fungi can be a mold or yeast. Some fungi can exhibit both forms depending on the temperature they are grown at. Yeasts can be unicellular to colonial short-chains and are oval to round in shape. Molds exhibit multicellular filamentous growth (mycelium) that differentiates into morphologically distinct parts. Most fungi are beneficial, but a few (<200 species) can be harmful. Fungi prefer to grow in a moist and warm environment. Special media, different temperatures, and special stains are all used to identify fungi depending on the source of infection. Most often fungi are identified by their macroscopic and microscopic morphology.

Fungi are classified in two ways: the type of sexual spore produced or on type of disease caused. The current classes based on the type of reproductive spore produced are:

- Zygomycetes: form a zygospore (e.g. *Rhizopus nigricans*, the bread mold)
- Ascomycetes: form an ascospore (e.g. penicillium molds and Saccharomyces yeast)
- Basidiomycetes: form a basidiospore (e.g. mushrooms and toadstools)
- Deuteromycetes: form no sexual reproductive spore, but only reproduce by asexual mechanisms (most organisms encountered in the clinical setting belong to this group).

Classification can also be based on the types of diseases fungi cause. The groups are superficial, cutaneous, subcutaneous, and systemic fungal diseases. One must remember that all fungi do not cause disease and healthy immunocompetent people have a high innate resistance to fungal infections. Most fungi are saprophytes. The rare fungi that are true pathogens always cause disease. Some fungi are opportunistic fungi; they cause disease when conditions become advantageous for them to do so, but this is primarily due defects in the immune system or a breach of the protective barriers of the skin and mucous membranes.

Superficial mycoses

There are three diseases that are superficial infections; infections that are at, or above the top layer of skin. They are Tinea versicolor which is caused by *Malassezia furfur*, white piedra caused by *Trichosporon beigelii* and black piedra caused by *Piedraia hortae*. These diseases are cosmetic in nature and are not life threatening.

The cutaneous mycoses are also termed Dermatomycoses because they involve the skin, hair and nails. Common names for these diseases are ringworm or tinea infections. There are three genera that cause the most common of all fungal infections. The genera are:

- Epidermophyton species infect skin and nails, but not hair
- Microsporum species infect skin and hair, but not nails
- Trichophyton species infect skin, hair and nails

Transmission is by coming in contact with spores, sometimes by direct contact with lesions, but more often by indirect contact. Spores are found in the soil (geophilic), other animals (zoophilic), or from humans (anthropophilic). There is some thought that some individuals have a genetic predisposition to get a fungal infection based on their immune system. Treatment of dermatophyte infections usually consists of local application of fungistatic compounds (Desenex©, Miconazole, etc.), especially to skin infections. Sometimes systemic antifungal agents are prescribed for nail or deeper skin infections. Naming the diseases is based on location of the infection:

- Tinea capitis (head)
- Tinea barbae (beard)
- Tinea corporis (body)
- Tinea cruris (groin)
- Tinea pedis (foot)
- Tinea unguium (nail)

Subcutaneous mycoses

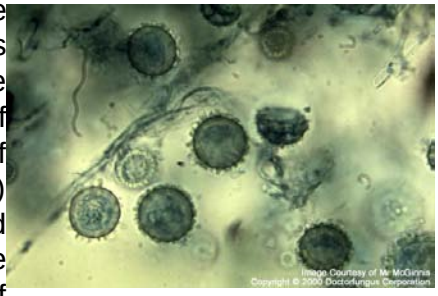
Subcutaneous mycoses are transmitted by direct inoculation beneath the skin. Most are diseases occur in third world countries where people often do not wear shoes and the soil inhabiting microbes penetrate the skin via thorn pricks. One organism that is seen in this country is *Sporothrix schenckii*, which causes sporotrichosis, (rose-gardener's disease). The primary lesion is due to contact with thorns that are contaminated with the organism. *Sporothrix* has been found to grow in sphagnum mosses which are used in peat moss. The disease manifests itself by a series of nodules running along

the lymphatic channels in skin. The organism is a dimorphic fungus; a yeast at 37°C and a mold at 25°C. In debilitated patients the organism may go systemic. Other subcutaneous infections include Chromoblastomycosis, Phaeohyphomycosis, and Mycetoma. These last diseases usually are chronic infections.

Systemic mycoses

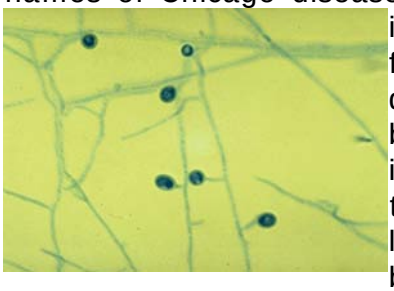
Systemic fungi infect the internal tissues of the body. These organisms are true pathogens and are usually dimorphic, producing a yeast phase at 37°C and a mold phase at 25°C. The organisms can easily live and reproduce in nature without infecting man. Man acquires the fungus by inhalation of spores. From the lungs, where the organism causes a primary pulmonary infection, the microbe can spread to other areas of the body via the blood stream. Systemic fungi often have a defined geographical distribution.

Histoplasma capsulatum causes histoplasmosis. Often the patient is asymptomatic (95% of the people exhibit no symptoms), but the fungus may cause pneumonia before dissemination to the reticuloendothelial system (RES). Granulomatous lesions can be found in lymph nodes and in the spleen. Progressive disease is usually fatal if untreated. Transmission of disease is by inhalation of spores that survive and flourish in bird (Starlings) and bat fecal material, soil rich in nitrogen, and decaying buildings. This organism is found in the Ohio and Mississippi River Valleys. A vast majority of the population in the endemic area exhibits a serological titer which indicates previous exposure to the organism. Key morphological characteristics that helps identify the organism include the production of a tuberculated macroconidia (see picture) at 25°C and cigar shaped yeast at 37°C.



Coccidioides immitis causes a disease called coccidioidomycosis. Common names of the disease (Valley Fever, San Joaquin Valley Fever, or California Fever) reflect the geographic location common to this microbe. This organism likes to live in an arid environment. As a mold at 25°C it produces arthroconidia, which are very infectious (only a few spores are necessary to cause an infection). *Coccidioides* is yeast at 37°C and produces characteristic spherules that contain endospores that can be seen in sputum or BAL specimens. Usually the disease produces a benign and self-healing lung granuloma. Sixty percent of the population never knew they had the disease. About forty percent of the population will recall a mild respiratory infection. Transmission is by inhalation of spores. Dissemination to other body sites generally only occurs in the immunocompromised individual. After the San Francisco Bay earthquake of 1989, there was an increase in the number of cases of coccidioidomycosis. Why?

Blastomyces dermatitidis causes North American blastomycosis, (common names of Chicago disease or Gilchrist's disease). It is a relatively common infection of dogs in endemic areas where the fungus lives in cool, damp conditions. This dimorphic fungus is yeast at 37°C (note the broad base) and a mold at 25°C. Transmission is by inhalation of spores. The primary lesion is found in the lungs (pulmonary blastomycosis). Extensive lung involvement may resemble TB. Invasion of blood to other sites may cause chronic systemic granulomas (such as cutaneous blastomycosis), though it is rarely fatal. Disease may be limited to granulomas of skin and lungs. Treatment of systemic mycoses is Amphotericin B, a potent but toxic antifungal agent. All systemic mycoses have increased in HIV and immunosuppressed individuals.



Opportunistic infections

Because of the ever increasing invasive technology available today, modern medicine is keeping patients alive today whereas before they would usually have succumbed to their disease. As a result these patients are much more debilitated and open to opportunistic fungal infections. Fungi, some because they are ubiquitous and some because they are normal flora, play a key role in opportunistic infections in immunosuppressed individuals. A number of opportunistic fungal diseases are presented below.

Candida albicans causes candidiasis or thrush in debilitated individuals. This organism is always seen as yeast and is normal flora. Debilitation or loss of bacterial flora predisposes to the pathogenic condition. Lesions and furry growth in the mouth, vagina, skin, nails, bronchi or lungs are typical manifestations. Systemic invasion is often fatal. Over-the-counter treatments are available for some superficial Candida infections.

Cryptococcus neoformans is always seen as yeast cells with a heavy capsule. It causes the disease cryptococcosis. *Cryptococcus* grows in bird feces, esp. pigeons. Transmission is by inhalation of yeast cells. Infection starts in the lungs but extension to the brain results in chronic meningitis which is often fatal. This disease has increased tremendously in occurrence in the AIDS population.

Another fungus that primarily affects debilitated and immunocompromised patient, especially those with AIDS is *Pneumocystis jiroveci* (formally *P. carinii*). It causes pneumocystis pneumonia (an interstitial pneumonia) and is one reason for death in this population. *P. (carinii) jiroveci* is always seen as yeast-like cells and was only recently moved from protozoan classification to that of a fungus after careful molecular research. Generally the organism exists as occasional normal flora not causing disease in healthy individuals. However as an opportunist in immune compromised, it causes non-productive cough with frothy sputum. Until recently with the use of highly

active antiretroviral therapy (HAART), this organism was the number one killer of patients with AIDS.

Aspergillosis is the most common invasive mold infection worldwide. *Aspergillus species* are found in soil, compost heaps, and construction sites. Inhalation of spores can result in allergic reactions or actual infection of sinuses, bronchi or lungs. In debilitated hosts the organism can penetrate blood vessels.